examined*. In these plants the section of the central bundle exhibits a form of the letter H. The vessels of the large central transverse bar are all reticulated ones: the greater part of those of the terminal vertical bars are of the same character; but the outermost vessels of those latter structures are barred or quasi-scalariform. As in the case of *R. duplex*, already described, these outermost layers of barred vessels, accompanied by a few reticulated ones, become detached alternately from opposite sides of the H-shaped central bundle. Passing quickly through a thin delicate cellular inner bark, they enter the coarser parenchyma of a middle one, as two irregular clusters of vessels with one common investment prolonged from the innermost bark. On reaching the outer bark they become two distinct cylindrical bundles, each with its own delicate cortical investing layer; and thus invested, they emerge from the primary petiole to supply the secondary rachis.

The Oldham specimens of *Rachiopteris bibractiensis* agree with those described by M. Renault in having all their vessels of the barred type. The outer bark projects at numerous points in large conical abortive hairs, which almost assume a spinous aspect.

The author further figures and describes the section of a vascular axis, with a central cellular medulla surrounded by five contiguous crescentic masses of vascular tissue, whose concavities are directed outwards. This plant appears identical with the *Anarchopteris Decaisnii* of Renault.

II. "On the Motions of some of the Nebulæ towards or from the Earth." By William Huggins, D.C.L., LL.D., F.R.S.

Received January 26, 1874.

The observations on the motions of some of the stars towards and from the earth which I had the honour to present to the Royal Society in 1872 appeared to show, from the position in the heavens of the approaching and receding stars, as well as from the relative velocities of their approach and recession, that the sun's motion in space could not be regarded as the sole cause of these motions. "There can be little doubt but that in the observed stellar movements we have to do with two other independent motions—namely, a movement common to certain groups of stars, and also a motion peculiar to each star"†.

It presented itself to me as a matter of some importance to endeavour to extend this inquiry to the nebulæ, as it seemed possible that some light might be thrown on the cosmical relations of the gaseous nebulæ to the stars and to our stellar system by observations of their motions of recession and of approach.

Since the date of the paper to which I have referred, I have availed

* Annales des Sciences Naturelles, 5e série, Bot. tome xii.

† Proceedings of the Royal Society, vol. xx. p. 392.

myself of the nights sufficiently fine (unusually few even for our unfavourable climate) to make observations on this point.

The inquiry was found to be one of great difficulty, from the faintness of the objects and the very minute alteration in position in the spectrum which had to be observed.

At first the inquiry appeared hopeless, from the circumstance that the brightest line in the nebular spectrum is not sufficiently coincident in character and position with the brightest line in the spectrum of nitrogen to permit this line to be used as a fiducial line of comparison. The line in the spectrum of the nebulæ is narrow and defined, while the line of nitrogen is double, and each component is nebulous and broader than the line of the nebulæ. The nebular line is apparently coincident with the middle of the less refrangible line of the double line of nitrogen*.

The third and fourth lines of the nebular spectrum are undoubtedly those of hydrogen; but their great faintness makes it impossible to use them as lines of comparison under the necessary conditions of great dispersive power, except in the case of the brightest nebulæ.

The second line, as I showed in the paper to which I have referred, is sensibly coincident with an iron line, wave-length 495·7; but this line is inconveniently faint, except in the brightest nebulæ.

In the course of some other experiments my attention was directed to a line in the spectrum of lead which falls upon the less refrangible of the components of the double line of nitrogen. This line appeared to meet the requirements of the case, as it is narrow, of a width corresponding to the slit, defined at both edges, and in the position in the spectrum of the brightest of the lines of the nebulæ.

In December 1872 I compared this line directly with the first line in the spectrum of the Great Nebula in Orion. I was delighted to find this line sufficiently coincident in position to serve as a fiducial line of comparison.

I am not prepared to say that the coincidence is perfect; on the contrary, I believe that if greater prism-power could be brought to bear upon the nebulæ, the line in the lead spectrum would be found to be in a small degree more refrangible than the line in the nebulæ.

The spectroscope employed in these observations contains two compound prisms, each giving a dispersion of 9° 6′ from A to H. A magnifying-power of 16 diameters was used.

In the simultaneous observation of the two lines it was found that if the lead line was made rather less bright than the nebular line, the small excess of apparent breadth of this latter line, from its greater brightness, appeared to overlap the lead line to a very small amount on its less refrangible side, so that the more refrangible sides of the two lines appeared to be in a straight line across the spectrum. This line could be

* Proceedings of the Royal Society, vol. xx. p. 380.

therefore conveniently employed as a fiducial line in the observations I had in view.

In my own map of the spectrum of lead this line is not given. In Thalén's map (1868) the line is represented by a short line to show that, under the conditions of spark under which Thalén observed, this line was emitted by those portions only of the vapour of lead which are close to the electrodes.

I find that by alterations of the character of the spark this line becomes long, and reaches from electrode to electrode. As some of those conditions (such as the absence of the Leyden jars, or the close approximation of the electrodes when the Leyden jars are in circuit) are those in which the lines of nitrogen of the air in which the spark is taken are faint or absent, the circumstance of the line becoming bright and long or faint and short, inversely as the line of nitrogen, suggested to me the possibility that the line might be due not to the vapour of lead, but to some combination of nitrogen under the presence of lead vapour. As, however, this line is bright under similar conditions when the spark is taken in a current of hydrogen, this supposition cannot be correct.

A condition of the spark may be obtained in which the strongest lines of the ordinary lead spectrum are scarcely visible, and the line under consideration becomes the strongest in the spectrum, with the exception of the bright line in the extreme violet.

I need scarcely remark that the circumstance of making use of this line for the purpose of a standard line of comparison is not to be taken as affording any evidence in favour of the existence of lead in the nebulæ.

Each nebula was observed on several nights, so that the whole observing time of the past year was devoted to this inquiry. In no instance was any change of relative position of the nebular line and the lead line detected.

It follows that none of the nebulæ observed shows a motion of translation so great as 25 miles per second, including the earth's motion at the time. This motion must be considered in the results to be drawn from the observations; for if the earth's motion be, say, 10 miles per second from the nebula, then the nebula would not be receding with a velocity greater than 15 miles per second; but the nebula might be approaching with velocity as great as 35 miles per second, because 10 miles of this velocity would be destroyed by the earth's motion in the contrary direction.

The observations seem to show that the gaseous nebulæ as a class have not proper motions so great as the bright stars. It may be remarked that two other kinds of motion may exist in the nebulæ, and, if sufficiently rapid, may be detected by the spectroscope:—1. A motion of rotation in the planetary nebulæ, which might be discovered by placing the slit of the instrument on opposite limbs of the nebulæ. 2. A motion

of translation in the visual direction of some portions of the nebulous matter within the nebula, which might be found by comparing the different parts of a large and bright nebula.

Sir William Herschel states that "nebulæ were generally detected in certain directions rather than in others, that the spaces preceding them were generally quite deprived of stars, that the nebulæ appeared some time after among stars of a certain considerable size and but seldom among very small stars, that when I came to one nebula I found several more in the same neighbourhood, and afterwards a considerable time passed before I came to another parcel"*.

Since the existence of real nebulæ has been established by the use of the spectroscope, Mr. Proctor† and Professor D'Arrest‡ have called attention to the relation of position which the gaseous nebulæ hold to the Milky Way and the sidereal system.

It was with the hope of adding to our information on this point that these observations of the motions of the nebulæ were undertaken.

In the following list the numbers are taken from Sir J. Herschel's 'General Catalogue of Nebulæ.' The earth's motion given is the mean of the motions of the different days of observation.

No.	h.	H.	Others.	Earth's motion from Nebula.
1179	360	..	M. 42	7 miles per second.
4234	1970	..	Σ. 5	12 " "
4373	..	IV. 37.	..	1 " "
4390	2000	..	Σ. 6	2 " "
4447	2023	..	M. 57	3 " "
4510	2047	IV. 51.	..	14 " "
4964	2241	IV. 18.	..	13 " "

III. "On the Annual Variation of the Magnetic Declination." By J. A. Broun, F.R.S. Received February 11, 1874.

The first observations which seemed to show that the mean position of the declination-needle followed an annual law were those of Cassini, made, more than eighty years ago, in the hall of the Paris Observatory and in the *caves* below it (90 feet under ground). It cannot be said, however, that Cassini's result has been confirmed by subsequent observations, either as regards the direction or amounts of movement from month to month.

The extensive series of observations made in different parts of the

* Philosophical Transactions, 1784, p. 448.

† Other Worlds than Ours, pp. 280–290.

‡ Astronomische Nachrichten, No. 1908, p. 190.